THE ENGINEERING FOUNDATION

A PROGRESS REPORT TO UNITED ENGINEERING SOCIETY

AMERICAN SOCIETY OF CIVIL ENGINEERS
AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS
AMERICAN SOCIETY OF MECHANICAL ENGINEERS
AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

PUBLICATION
NUMBER 2

ENGINEERING SOCIETIES BUILDING
NEW YORK CITY
OCTOBER, 1919

AMBROSE SWASEY

THE
ENGINEERING FOUNDATION

A PROGRESS REPORT TO
UNITED ENGINEERING SOCIETY

AMERICAN SOCIETY OF CIVIL ENGINEERS
AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS
AMERICAN SOCIETY OF MECHANICAL ENGINEERS
AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

PUBLICATION
NUMBER 2

ENGINEERING SOCIETIES BUILDING
NEW YORK CITY
OCTOBER, 1919

TABLE OF CONTENTS

UNITED ENGINEERING SOCIETY

INCORPORATED UNDER CHAPTER 703, LAWS OF THE STATE OF NEW YORK, MAY 11, 1904.

UNITED ENGINEERING SOCIETY holds certain endowments and administers certain interests for four Founder Societies, namely: the American Society of Civil Engineers, the American Institute of Mining and Metallurgical Engineers, the American Society of Mechanical Engineers and the American Institute of Electrical Engineers. United Engineering Society holds and administers the Engineering Societies building. It has three departments, Engineering Societies Library Board, Engineering Foundation Board, and Engineering Council. By its charter the Society is empowered to take real and personal property by grant, devise or bequest, and to use, maintain, occupy, lease, mortgage and convey the same. It may receive from any source moneys or other property for its own purposes, or for any other endowment or activity within the scope of its charter. The objects of this Society are to advance the engineering arts and sciences in all their branches, and to maintain a free public engineering library. Its business is conducted by a board of twelve trustees, three from each Founder Society. Charles F. Rand is President of United Engineering Society.

THE ENGINEERING FOUNDATION

THE Engineering Foundation is an outgrowth of various influences. For many years, groups of men, working through different organizations, have been seeking to extend social intercourse among engineers, to create channels for the interchange of engineering experiences, and to advance the standards of engineering practice. The American Society of Civil Engineers, the American Institute of Mining and Metallurgical Engineers, the American Society of Mechanical Engineers and the American Institute of Electrical Engineers are the result of such efforts put forth by men in the several fields of engineering which they respectively represent. Through the instrumentality of these organizations small groups of men have increased to thousands; the contributions of individual members, and of committees of members making up a record of the proceedings of the organizations, constitute a history of professional achievement in the fields they represent.

The progress early achieved by these societies has served naturally to stimulate efforts in the further development of their common interests. In 1904, initial steps were taken which have since resulted in the establishment of the United Engineering Society, the purpose of which was to bring into a single organization representatives of the four societies already named, now commonly referred to as the Founder Societies, and out of the activities of the United Engineering Society an organization for the encouragement of engineering research has appeared. This became possible through the presentation to the United Engineering Society of a sum of money as a trust fund, the interest of which was to be used in the promotion of engineering research. This resulted in the Engineering Foundation.

It is important in this connection to emphasize the fact that the Engineering Foundation is an instrumentality created in the interest of engineering research, as this may be made manifest through the activities and purposes of the four Founder Societies. Engineering Foundation has no life apart from the Society life. Its purpose is to make contribution to the enlargement of engineering practice and in

so doing to exalt the profession of Engineering. Engineering Foundation is not designed to lead a separate and independent existence, to compete with preëxisting engineering organizations, but on the contrary it is one of the many results built up by the work of the Founder Societies. It is a child of the Founder Societies, it expects to be nurtured by them, it gladly acknowledges its fealty to them.

Engineering Foundation Board is a department of United Engineering Society, a body created by the Founder Societies comprising a membership of forty thousand engineers, to discharge certain functions for them; but it is not a separate independent organization under State corporation laws. Its sixteen members are elected by United Engineering Society; thirteen must be members of the Founder Societies, and eight of the thirteen are nominated severally by the governing bodies of the Founder Societies. Hitherto, the members at large, although not necessarily engineers, have also all been members of Founder Societies. As a matter of fact, therefore, the Engineering Foundation Board has always been composed wholly of members of the Founder Societies. Hence, this Board is a body of trustees created by, and representative of, these four great National engineering societies, acting for them in the administration of certain funds which have been given, and of others which may be given, for research for the advancement of the profession and for the good of mankind. Consequently the Foundation Board is in effect the trustee in these matters for the whole body of American engineers. It is their instrumentality for the stimulation, direction and support of research. It is, furthermore, the liaison agency between engineers on one hand and other technologists and scientists on the other hand, in activities concerned with research in all branches of the mathematical, physical and biological sciences.

Engineering Foundation Board keenly appreciates its opportunities and its obligations growing out of the trusteeship for the Profession thus committed to it by the Founder Societies. It looks, therefore, to its parent societies for the correlation of their research activities under its guidance so that each and every engineer may secure the maximum benefit from all engineering research. It expects, also, the generous support of its parent societies in undertaking larger work for the advancement of the profession, through the agency of the National Research Council, which it has helped to create, through other channels now open, and through still others which may be opened.

THE FOUNDER

AMBROSE SWASEY was born at Exeter, New Hampshire, December 19, 1846, of New England lineage. He commenced and completed his schooling in one of those familiar landmarks of his native countryside, the district schoolhouse.

When eighteen years old, he began in Exeter to learn the machinist's trade. At twenty-three, with Worcester Reed Warner, he went to the Pratt & Whitney Company, in Hartford, Connecticut. In 1880, these two men removed to Cleveland, Ohio, and established the business in which their names have since been linked,—the manufacture of fine machine tools and of astronomical and other instruments of precision. He invented the epicycloidal milling machine for generating the true curves of gear teeth, a process for cutting spur gears exactly, and the Swasey range and position finder for artillery. He designed a dividing engine capable of graduating automatically circles up to 40 inches diameter with an error of less than one second of arc.

Among the noteworthy telescope mountings built by his company are the 36-inch Lick refractor, erected at Mount Hamilton, California (1886); the 26-inch telescope of the Naval Observatory at Washington (1890); the 40-inch telescope, 90-foot dome and the 75-foot elevating floor of the Yerkes Observatory, at Williams Bay, Wisconsin (1894), and the 72-inch reflecting telescope of the Dominion Astronomical Observatory, at Victoria, British Columbia (1916).

Mr. Swasey is the author of "A New Process for Generating and Cutting the Teeth of Spur Wheels" and "Some Refinements of Mechanical Science," published in the "Transactions of the American Society of Mechanical Engineers," Vol. XII (1890) and Vol. XXVI (1904); "The Eiffel Tower from Foundation to Lantern" and "The Specialist in Engineering," published in the "Journal" of the Association of Engineering Societies, Vol. IX (1890) and Vol. XIV (1895).

Ambrose Swasey is not only an engineer and manufacturer, but also a traveler and philanthropist. He has journeyed widely in his native land and foreign countries. He has twice circled the earth,

and in 1917 for the third time visited China. Among his public gifts are the Astronomical Observatory of Denison University; the Science Building of the University of Nanking, China; the Christian Association Building of the Canton (China) Christian College; the beautiful Pavilion for his native town of Exeter, and the endowment funds for the Engineering Foundation.

He is an organizing member, past-president and honorary member of the American Society of Mechanical Engineers; past-president and honorary member of the Cleveland Engineering Society; honorary member of the New Hampshire Society of the Cincinnati; past-president of the Cleveland Chamber of Commerce; member of the American Philosophical Society; member of the John Fritz Medal Board of Award, and member of the National Research Council, its Advisory Committee and its Division of Engineering. Mr. Swasey is a fellow of the Royal Astronomical Society of London, a member of the British Astronomical Association and the Institution of Mechanical Engineers of Great Britain. He is a member of the Union Club, Cleveland; the Engineers Club, New York, and the Cosmos Club, Washington. He was a member of the Jury of Awards of the Nashville (1897), Pan-American (1901), and St. Louis (1904) expositions, and vice-president of the Jury of Awards of the Jamestown Exposition (1907). He was appointed by President Roosevelt in 1909 and President Taft in 1913 as a member of the Assay Commission to test coins in the Government's mints.

In 1905, Mr. Swasey was invested by the Case School of Applied Sciences, Cleveland, Ohio, with the doctorate of engineering; in 1910, he was granted the degree of Doctor of Science by Denison University, Granville, Ohio, and in 1900, the French Republic made him a Chevalier of the Legion of Honor, because of his achievements in the design and construction of astronomical instruments.

To be the founder of an institution for the good of mankind one must have faith and vision. These qualities, coupled with determination, patience, thoroughness, ingenuity, sagacity and kindliness, are conspicuous in the character of the man who gave, and continues to give, liberally his resources of personality and property for the creation and support of the Engineering Foundation.

INSTITUTION OF THE FOUNDATION

A DESIRE to exalt the work of the engineer and to add to the accumulated facts which serve to guide him in his undertakings, was long entertained by Ambrose Swasey. He discussed the matter with his friends, and gradually out of such discussions the outline of a procedure took form. In 1914, in the fulfilment of his desire, Mr. Swasey offered United Engineering Society two hundred thousand dollars as a nucleus of an endowment, the income of which should be used "for the furtherance of research in science and engineering, or for the advancement in any other manner of the profession of engineering and the good of mankind."

Official record of the negotiations which led to the institution of the Foundation appears for the first time in the minutes of the meeting of the Trustees of United Engineering Society, May 28, 1914. From these minutes the following passage is taken:

> The President reported orally that it had been his privilege to have a conference with an eminent engineer, who had expressed his desire to present to United Engineering Society a considerable fund for the advancement of the profession of engineering. In the initial and somewhat informal stages of the present time, it was the recommendation of the President that a special committee be appointed to consider and report upon the best means to accept the generous gift and administer and establish an engineering research foundation under the broad terms of the donor's expressed wishes. After discussion, it was decided that such a committee be appointed by the Chair and that it consist of six persons, two from each of the Founder Societies. On motion, the creation of such a Special Committee was approved, and it was made to consist of Dr. Alex. C. Humphreys, Chairman, Jesse M. Smith, Charles F. Rand, James F. Kemp, Gano Dunn and C. E. Scribner. On motion,
>
> *Resolved:* That the Secretary be authorized and directed to send a communication of appreciation to the intending donor, and advise him of the action of the Board.
>
> It was the emphatically expressed wish of the donor that his name should not be mentioned at the present stage of the negotiations.

United Engineering Society accepted the gift of Mr. Swasey and organized the Engineering Foundation Board, composed of Trustees of this Society, representatives of the Founder Societies and members at large, not necessarily engineers. This Board controls and administers the funds received by it from United Engineering Society.

In September, 1918, Mr. Swasey added one hundred thousand dollars to the endowment, making the present total three hundred thousand dollars.

LETTER OF GIFT

November 30, 1914.

PROFESSOR F. R. HUTTON, *Secretary,*
United Engineering Society,
New York City.

DEAR PROFESSOR HUTTON:

I am pleased to acknowledge receipt of yours of the 20th instant, also copy of the minutes of the Board of Trustees of November 19th, and I appreciate the courtesy of the Board in submitting them to me before final approval.

The name adopted, "The Engineering Foundation," is ideal, and the plan of organization and administration, as given in the minutes, is along the broadest lines and most admirable in every respect. I have no suggestions or recommendations to offer.

As soon as I am advised that the plan of organization of the Engineering Foundation, submitted, has become the law of the United Engineering Society, I will be pleased to transmit to the officer designated by the Society, the two hundred thousand dollars ($200,000) which constitutes my gift to the Society for the Engineering Foundation; the income only of which is to be used for the purposes of the Foundation.

As to the date of the general meeting when the plan of the Foundation is to be made public; if agreeable to the Board, it seems to me it would be well to have it some time during the last week in January.

I want the members of the Board to know how much I appreciate the interest they have manifested in working out the problems relative to the Foundation, and the pleasure it has given me to be associated with them in their splendid undertaking.

With all best wishes,

Very truly yours,

(Signed) AMBROSE SWASEY.

Note: Professor Hutton's letter of November 20, 1914, transmitted the report of the Committee of Six, mentioned on page 11, presented to United Engineering Society at its meeting, November 19. This report included a draft of by-laws later adopted with minor modifications. These by-laws, as subsequently amended, are printed on page 18.

LETTER ACCOMPANYING SECOND GIFT

September 28, 1918.

MR. CHARLES F. RAND, *President,*
United Engineering Society,
New York.

DEAR SIR:

The admirable manner in which the Engineering Foundation has been conducted, and the large measure of helpfulness it has extended to the engineering world, have been most gratifying to me and thoroughly justify its establishment.

In recognition of what had then been accomplished, it seemed to me in 1916 that it would be well to plan for its further extension, and I then made the United Engineering Society the beneficiary of a trust fund of $100,000, established with the Cleveland Trust Company. In 1917, from the income of this trust, $5,000 was contributed to the Foundation for the purpose of carrying forward its work.

The many vital problems created by war conditions give new opportunities to the Foundation, and impose added responsibilities upon it. In recognition of this I feel that the Foundation should now have the full benefit of the income from the fund established in 1916, and I am pleased to add to the previous gift of $200,000, the fund of $100,000, held in trust as above, to be on the same terms and conditions as my original gift.

The Board is at liberty to use its discretion as to whether the funds shall remain with the Cleveland Trust Company for a time, or be transferred to the custody of the United Engineering Society. In either case, I desire that the Foundation shall have the benefit of the income of this additional fund after September 1, 1918.

Very truly yours,

(Signed) AMBROSE SWASEY.

PROGRESS IN ORGANIZATION UNDER THE GIFT

APRIL 15, 1915, the Engineering Foundation Board held its organizing meeting. In October, 1916, United Engineering Society provided an office for the Foundation in Engineering Societies Building. As at first constituted, the Board had eleven members, elected by United Engineering Society, each serving for a term of three years or less: three trustees of United Engineering Society (one representative of each Founder Society);* one member nominated by the governing body of each Founder Society, not a trustee of United Engineering Society; two members of the American Society of Civil Engineers; two members at large, and the president of United Engineering Society. By amendment of the By-Laws of United Engineering Society, April 25, 1918, the Board was enlarged to sixteen members, elected by United Engineering Society: four trustees of United Engineering Society, one representing each Founder Society; two members from each Founder Society nominated by its governing body, who are not trustees of United Engineering Society; three members at large, and the president of United Engineering Society, *ex officio*. By this amendment also, an Executive Committee of five members was provided, composed of the chairman, the two vice-chairmen and two elected members. The membership of the enlarged board was completed in June, 1918. The additional members of the Executive Committee were elected in September, 1918, and it held its first meeting October 2, 1918.

Note: January 27, 1915, Wednesday, in the evening, inaugural ceremonies for the public acknowledgment of the first gift for Engineering Foundation were held in Engineering Societies Building, New York, preceded by a banquet, January 26, to Mr. Swasey. At the inaugural were present representatives of all branches of engineering and of the allied sciences. President Gano Dunn, of United Engineering Society, presided; other speakers were: Dr. Henry S. Pritchett, President, Carnegie Foundation for the Advancement of Teaching; Captain Robert W. Hunt, Past-President, American Society of Mechanical Engineers and American Institute of Mining Engineers; Charles McDonald, Past-President, American Society of Civil Engineers; Dr. Alex. C. Humphreys, President, Stevens Institute of Technology, and Past-President, American Society of Mechanical Engineers, and Ambrose Swasey, Past-President, American Society of Mechanical Engineers.

February 24, 1915, in the private room of the Astor Trust Company, New York, Mr. Swasey turned over to the custody of United Engineering Society the securities which constituted his gift.

* Originally there were only three Founder Societies. The American Society of Civil Engineers became a Founder Society in the year 1916.

OFFICERS AND MEMBERS OF THE FOUNDATION BOARD

Chairmen

Names	*Terms*
Gano Dunn	April, 1915, to February, 1917
Michael I. Pupin	February, 1917, to February, 1919
W. F. M. Goss	February, 1919, to date

First Vice-Chairman

Edward Dean Adams	May, 1915, to date

Second Vice-Chairmen

M. I. Pupin	February, 1916, to February, 1917
J. Waldo Smith	February, 1917, to March, 1918
W. F. M. Goss	March, 1918, to February, 1919
D. S. Jacobus	February, 1919, to date

Treasurer

Joseph Struthers	February, 1916, to date

Secretaries

Frederick R. Hutton	April 15, 1915, to September 15, 1916
Calvin W. Rice (Acting)	February 29, 1916, to September 14, 1916
Cary T. Hutchinson	September 15, 1916, to December 13, 1917
Alfred D. Flinn	December 13, 1917, to date

Assistant Secretaries

(*Secretaries of National Research Council, ex officio*)

John Johnston	September, 1916, to April, 1919
A. O. Leuschner (Acting)	April, 1919, to June 30, 1919
(*Vacant*)	June 30, 1919, to August 19, 1919
Harry O. Wood (Acting)	August 19, 1919, to October 14, 1919
Vernon Kellogg	October 1, 1919, to date

Executive Committees

September, 1918, to February, 1919

M. I. Pupin, *Chairman*
Edward Dean Adams
W. F. M. Goss
Charles Warren Hunt
Silas H. Woodard

February, 1919, to date

W. F. M. Goss, *Chairman*
Edward Dean Adams
D. S. Jacobus
H. Hobart Porter
Silas H. Woodard

FOUNDATION BOARDS

Note: Initials after names indicate society representation: U. E. S., trustee of United Engineering Society; A. S. C. E., American Society of Civil Engineers; A. I. M. E., American Institute of Mining and Metallurgical Engineers; A. S. M. E., American Society of Mechanical Engineers; A. I. E. E., American Institute of Electrical Engineers.

1915

ELEVEN MEMBERS

Benjamin B. Thayer, U.E.S.
Alex. C. Humphreys, U.E.S.
C. E. Scribner, U.E.S.
A. R. Ledoux, A.I.M.E.
Jesse M. Smith, A.S.M.E.
M. I. Pupin, A.I.E.E.
Charles Warren Hunt, A.S.C.E.
J. Waldo Smith, A.S.C.E.
Edward Dean Adams, At large
Howard Elliott, At large
Gano Dunn, Pres., U.E.S.

1916

ELEVEN MEMBERS

Gano Dunn, U.E.S.
*Alex. C. Humphreys, U.E.S.
†E. Gybbon Spilsbury, U.E.S.
Benjamin B. Thayer, U.E.S.
Robt. M. Raymond, A.I.M.E.
W. F. M. Goss, A.S.M.E.
M. I. Pupin, A.I.E.E.
Charles Warren Hunt, A.S.C.E.
J. Waldo Smith, A.S.C.E.
Edward Dean Adams, At large
Howard Elliott, At large
Charles F. Rand, Pres., U.E.S.

1917

ELEVEN MEMBERS

Gano Dunn, U.E.S.
E. Gybbon Spilsbury, U.E.S.
Benjamin B. Thayer, U.E.S.
Robert M. Raymond, A.I.M.E.
W. F. M. Goss, A.S.M.E.
M. I. Pupin, A.I.E.E.
Charles Warren Hunt, A.S.C.E.
J. Waldo Smith, A.S.C.E.
Edward Dean Adams, At large
Howard Elliott, At large
Charles F. Rand, Pres., U.E.S.

1918

SIXTEEN MEMBERS

Charles Warren Hunt, U.E.S.
Benjamin B. Thayer, U.E.S.
E. Gybbon Spilsbury, U.E.S.
Calvert Townley, U.E.S.
J. Waldo Smith, A.S.C.E.
Silas H. Woodard, A.S.C.E.
Robt. M. Raymond, A.I.M.E.
Joseph W. Richards, A.I.M.E.
W. F. M. Goss, A.S.M.E.
D. S. Jacobus, A.S.M.E.
M. I. Pupin, A.I.E.E.
E. Wilbur Rice, Jr., A.I.E.E.
Edward Dean Adams, At large
Howard Elliott, At large
H. Hobart Porter, At large
Charles F. Rand, Pres., U.E.S.

* Resigned. † Elected June 22, 1916, to succeed Alex. C. Humphreys.

1919

SIXTEEN MEMBERS

CHARLES WARREN HUNT, U.E.S., Secretary, American Society of Civil Engineers
BENJAMIN B. THAYER, U.E.S., Vice-President, Anaconda Copper Mining Company
E. GYBBON SPILSBURY, U.E.S., Consulting Engineer, E. G. Spilsbury Engineering Co.
CALVERT TOWNLEY, U.E.S., Assistant to President, Westinghouse Electric & Mfg. Co.
J. WALDO SMITH, A.S.C.E., Chief Engineer, Board of Water Supply of City of N. Y.
SILAS H. WOODARD, A.S.C.E., Consulting Engineer
ROBERT M. RAYMOND, A.I.M.E., Mining Engineer, Professor of Mining Engineering, School of Mines, Columbia University
JOSEPH W. RICHARDS, A.I.M.E., Professor of Metallurgy, Lehigh University
W. F. M. GOSS, A.S.M.E., President, Railway Car Manufacturers Association
DAVID S. JACOBUS, A.S.M.E., Advisory Engineer, Babcock and Wilcox Company
FRANK B. JEWETT, A.I.E.E., Chief Engineer, Western Electric Company
E. WILBUR RICE, JR., A.I.E.E., President, General Electric Company
EDWARD DEAN ADAMS, At large, Engineer-Financier
HOWARD ELLIOTT, At large, President and Chairman of Executive Committee, Northern Pacific Railway Company
H. HOBART PORTER, At large, President, American Water Works and Electric Company (Sanderson & Porter)
CHARLES F. RAND, President, U.E.S., Owner and Operator of Iron and Manganese Mines

BY-LAWS OF UNITED ENGINEERING SOCIETY RELATING TO ENGINEERING FOUNDATION

97. The United Engineering Society shall establish and maintain a fund to be known as the Engineeering Foundation.

98. The Engineering Foundation shall be controlled and administered by a board to be known as the Engineering Foundation Board. It shall have discretionary power under the By-Laws in the disposition of funds received by it from the United Engineering Society for the purposes of the Engineering Foundation.

99. The Engineering Foundation Board may use any part of such funds, and in any manner which it deems proper, for the furtherance of research in science and engineering, or for the advancement in any other manner of the profession of engineering and the good of mankind; and may make known to the world the results of its undertakings by publication, by public lectures or by other means in its discretion.

100. The Engineering Foundation Board shall consist of sixteen members, each to serve for a term of three years or until his successor is elected, and to be eligible for re-election for one term, except as stipulated in Section 101. Terms shall expire at annual meetings of the Engineering Foundation Board.

101. Fifteen members shall be elected by United Engineering Society as follows: One Trustee of United Engineering Society representing each Founder Society, two members from each Founder Society nominated by its governing body, who are not Trustees of United Engineering Society, and three members at large. The President of United Engineering Society, *ex officio*, shall be a member of the Engineering Foundation Board. The term of each member who is elected as a Trustee of United Engineering Society shall be limited to the time he remains a Trustee. Elections by United Engineering Society shall be at its annual meetings, or as soon thereafter as practicable. Vacancies shall be filled in the same manner as the original election.

102. Regular meetings of the Engineering Foundation Board shall be held on the second Thursday of February, May, September and December of each year. The February meeting shall be the annual meeting. Special meetings may be called at the option of the Chairman on not less than seven days' notice, and must be called by the Chairman or Secretary on the written request of three or more members. No business shall be transacted at a special meeting other than that stated in the call.

103. A quorum of the Engineering Foundation Board shall be five members.

104. At the annual meeting, the Engineering Foundation Board shall elect from among its members a Chairman and two Vice-Chairmen to serve for one year, or until their successors are elected.

105. There shall be an executive committee of five members, namely, the Chairman, the two Vice-Chairmen, and two members of Engineering Foundation Board elected at the annual meeting.

106. The Board at the annual meeting shall elect a Secretary to serve for one year or until his successor is elected. The Secretary shall have no vote unless he is a member of the Board.

107. The Treasurer of United Engineering Society shall be the Treasurer of the Engineering Foundation and shall attend the meetings of the Engineering Foundation Board, but shall have no vote unless a member of the Board.

108. The Engineering Foundation Board shall prepare and present to the annual meeting of United Engineering Society a report covering the work which it has undertaken during the year and the progress made, together with a complete and itemized financial statement.

RELATIONSHIPS AND POLICIES

THE Engineering Foundation Board is charged with the responsibility of administering funds placed at its disposal. In the discharge of this responsibility it is the desire of the Board to be guided by the intent of the Letter of Gift. The Board's purpose is to surround its expenditures with every practicable safeguard. It supports no project, the merits of which have not been demonstrated by competent inquiry. In the development of such inquiry, it is fortunate in possessing the coöperation of the National Research Council, an organization having world-wide scientific affiliations. In the execution of work incidental to its researches, the Board will always be informed in detail of expenditures made from its grants and concerning progress of the work. While the Engineering Foundation Board reserves to itself the right to choose, initiate and conduct under its own immediate direction, such researches as may commend themselves to its membership, it is at the present time making extensive use of certain channels established by the National Research Council, notably the Council's Division of Engineering.

As its work develops, the Foundation will have need for additional resources. In seeking increments to its endowment, the Foundation is able to assure prospective benefactors that funds given in perpetuity will be used for the purposes intended not only in the immediate future, but also in more distant years. The facts that the purposes for which funds are given are broadly stated; that the principal is to be held on such terms and conditions that the income can always be used "for the furtherance of research in science and engineering, or for the advancement in any other manner of the profession of engineering and the good of mankind," make the purposes secure, notwithstanding the passage of time and the resulting progress of civilization.

WORK ACCOMPLISHED

COÖPERATION WITH NATIONAL RESEARCH COUNCIL*

IN April, 1916, following the German submarine attack on the *Sussex*, President Wilson requested the National Academy of Sciences, chartered by Congress in 1863, to bring into coöperation governmental, educational, industrial and other research agencies in the interest of National defense and scientific and industrial research. There resulted the National Research Council, an organization of scientists, engineers and educators.

June 21, 1916, Engineering Foundation Board, at a meeting in New York, at which members of the National Academy of Sciences were present, decided to aid the Academy in the task assigned to it by the President. No funds having been provided, Engineering Foundation agreed to devote its resources to the National Research Council for one year, from September, 1916. In fulfilment of this agreement, the Foundation gave the use of its offices in Engineering Societies Building, the services of its secretary, and its income, increased by special gifts for this purpose from Ambrose Swasey and Edward Dean Adams.

To strengthen the bond, the secretary of each organization was made *ex officio* an assistant secretary, without salary, of the other organization. This arrangement continues. As assistant secretary of National Research Council, the secretary of Engineering Foundation became a member of the Executive Board of the Council.

At a special meeting of the Engineering Foundation Board held September 5, 1917, the Chairman read the following resolution adopted by the National Research Council at a recent meeting:

> As the year for which the coöperative arrangement was made between the Engineering Foundation and the National Research Council will soon expire, the Research Council wishes again to record its high appreciation of the liberal financial and personal assistance which the Foundation and its members have

* The first formal publication of Engineering Foundation, issued under date of February, 1917, entitled "Report on the Origin, Foundation and Scope of the National Research Council," presents in detail the earlier steps in the development of the Foundation's coöperative relations with the Council.

afforded in the organization and support of the work of the Council in this first year of its existence. It seems exceedingly desirable to maintain close relations between engineers and research workers which the Research Council has for the first time succeeded in establishing. Accordingly the Council wishes to express the hope that it may be practicable to continue some effective form of co-operation between the two bodies and it would be glad to appoint representatives to consider this matter with men designated by the Foundation.

At a meeting of the Foundation Board held September 20, 1917, the following resolution was unanimously adopted:

Resolved: That the Engineering Foundation receives with pleasure the resolution of the National Research Council expressing appreciation of the financial and personal assistance rendered to the organization and work of the Council during the past year. Reciprocating the Council's desire for the maintenance of close relations between workers in science and in engineering, the Foundation hereby declares that it will be its policy to continue the coöperation between the two bodies in all practicable ways that may be now, or may become, mutually available, such ways consisting of the interchange of helpful suggestions, advice, information, office representation and similar facilities, and in addition a recognition of community of purpose that shall promote in the field of engineering research increasingly intimate relations between engineering and science.

The reciprocal designation of the Secretary of each of the bodies as an assistant Secretary of the other for the purpose of enabling both bodies to have offices in both New York and Washington is favorably regarded, and the Foundation welcomes and gladly accepts the offered assistance of the Research Council in the national co-relation of the engineering research work of the Foundation to which the Foundation's resources will be devoted.

In total, sixty members of the Founder Societies are members of National Research Council, and of these, eight are members of the Foundation Board. The total membership of National Research Council is about one hundred and seventy-five. One member of Engineering Foundation Board and its Secretary, and thirty-one additional members of the Founder Societies, are members of the National Research Council in divisions other than the Division of Engineering and on its Executive Board. Engineers have, therefore, an influential position in the Council and a large measure of responsibility for its success.

Division of Engineering, of the Council

With the coöperation of the Engineering Foundation and a number of national engineering societies, National Research Council formed an Engineering Committee, which was active until the cessation of hostilities. Soon after the Armistice was signed, a Division of Engineering was substituted, "to carry out the general purpose of co-

ordinating the scientific resources of the entire country as regards engineering and to secure the coöperation of all engineering agencies in which research facilities are available."

Under the able leadership of Henry M. Howe, as chairman, with Galen H. Clevenger, as vice-chairman, the Division of Engineering was organized early in 1919 and a program of research initiated. With this division Engineering Foundation is closely bound. Every member of the Division of Engineering has membership in one or more of the Founder Societies. Seven are also members of the Engineering Foundation Board.

In August, Dr. Howe found it imperative for him to relinquish the duties of the chairmanship on account of limitations of health, and Mr. Clevenger resigned because of the necessities of his professional practice. Prof. Comfort A. Adams, dean of Harvard Engineering School, Harvard University, and past-president of the American Institute of Electrical Engineers, has been chosen chairman of the Division and Dr. Howe has been elected honorary chairman.

At present the Division has eighteen committees, each charged with a specific line of research and together covering a wide variety of subjects of interest to engineers and the industries.

Members of the Division of Engineering

Representatives of American Society of Civil Engineers

Anson Marston,[1] Dean of Engineering, Iowa State College.

H. Hobart Porter,[1, 2, 3, 4, 5] President, American Water Works & Electric Company (Sanderson & Porter).

George S. Webster,[1] Director, Department of Wharves, Docks and Ferries, Philadelphia.

Representatives of American Institute of Mining and Metallurgical Engineers

Hennen Jennings,[2] Mining Engineer.

Philip N. Moore,[2] Consulting Mining Engineer and Geologist.

Joseph W. Richards,[2, 5] Professor of Metallurgy, Lehigh University.

Representatives of American Society of Mechanical Engineers

Arthur M. Greene,[3] Professor of Mechanical Engineering, Rensselaer Polytechnic Institute.

W. F. M. Goss,[3, 4, 5] President, Railway Car Manufacturers Association.

D. S. Jacobus,[2, 3, 4, 5] Advisory Engineer, The Babcock & Wilcox Company.

Representatives of American Institute of Electrical Engineers

Comfort A. Adams,[3, 4] Lawrence Professor of Engineering and Dean of Harvard Engineering School, Harvard University.

Frank B. Jewett,[4, 5] Chief Engineer, Western Electric Company.

Willis R. Whitney,[2, 4] Director, Research Laboratory, General Electric Company.

Representative of American Society for Testing Materials

A. A. STEVENSON,[2, 3] Vice-President and Engineer, Standard Steel Works.

Representative of Illuminating Engineering Society

EDWARD P. HYDE,[4] Director, Nela Research Laboratory, National Lamp Works, General Electric Company.

Representative of Western Society of Engineers

ARTHUR N. TALBOT,[1, 3] Professor of Municipal and Sanitary Engineering, University of Illinois.

Representative of Society of Automotive Engineers

CHARLES F. KETTERING,[3, 4] Vice-President, The Dayton Engineering Laboratories Company.

Members at Large

HENRY M. HOWE,[2] Professor Emeritus of Metallurgy, Columbia University.
GALEN H. CLEVENGER,[2] Consulting Metallurgist.
EDWARD DEAN ADAMS,[1, 4, 5] Engineer-Financier.
JOHN J. CARTY,[4] Chief Engineer, American Telephone and Telegraph Company.
GANO DUNN,[1, 3, 4] President, J. G. White Engineering Corporation.
VAN H. MANNING,[2] Director, U. S. Bureau of Mines.
CHARLES F. RAND,[2, 5] Owner and Operator of Iron and Manganese Mines.
E. GYBBON SPILSBURY,[1, 2, 3, 5] Consulting Mining and Metallurgical Engineer.
BRADLEY STOUGHTON,[2] Consulting Metallurgist.
S. W. STRATTON,[3, 4] Director, Bureau of Standards.
AMBROSE SWASEY,[3] President, The Warner & Swasey Company.
WILLIAM R. WALKER,[2] Assistant to President, U. S. Steel Corporation.
A representative of the Government Division. (Not yet named.)

[1] Member of American Society of Civil Engineers.
[2] Member of American Institute of Mining and Metallurgical Engineers.
[3] Member of American Society of Mechanical Engineers.
[4] Member of American Institute of Electrical Engineers.
[5] Member of Engineering Foundation Board.

Note: No differentiation has been made above as to grade of membership.

GENERAL RELATIONS OF THE FOUNDATION WITH THE DIVISION OF ENGINEERING

AT a meeting of the Engineering Foundation Board held February 13, 1919, a special committee was appointed on Relations with National Research Council, of which W. F. M. Goss was chairman and the other members were Charles Warren Hunt, Silas H. Woodard and Frank B. Jewett. Under date of April 10, this committee reported as follows:

YOUR Committee on Relations with National Research Council, after several meetings and conferences, recommends the approval by the Foundation Board of the following proposals:

1. Engineering Foundation, recognizing the desirability of maintaining close affiliation with National Research Council, proposes to collaborate with the Council "for

the furtherance of research in science and engineering, or for the advancement in any other manner of the profession of engineering and the good of mankind."

2. To contribute to the above end, as part of the policy of Engineering Foundation, office space in Engineering Societies Building has been engaged at the expense of Engineering Foundation, in addition to its own requirements, to serve as the New York office of the Engineering Division of the National Research Council, beginning May 1, 1919, and the Foundation, having brought its office to an adjacent room, in addition proffers to the Council and its Engineering Division, without charge, such secretarial services as the Foundation may from time to time determine.

3. National Research Council has proposed that its Engineering Division, comprising in all not less than 23 nor more than 28 members (of whom at least 7 and not more than 12 shall be members at large), be so organized as to include at least 5 members of Engineering Foundation, and (including these 5) 17 members of the Founder Societies. Engineering Foundation accepts this proposal as well calculated to meet the mutual requirements of the Foundation and the National Research Council.

4. Engineering Foundation proposes to collaborate with National Research Council in the activities of its Engineering Division and to make such appropriations of funds to aid specific undertakings of the Division as the Foundation may from time to time determine.

5. It is understood that all publications relating to research work in which the Foundation shall have participated, will be issued under the joint names of the Engineering Foundation and the National Research Council.

At a meeting April 10, the Executive Committee voted to recommend this report to the Foundation Board for adoption. April 22, at a special meeting of Engineering Foundation Board, evidences were presented of the acceptability to National Research Council of the proposed relations, in the form of notes of the meeting of the Engineering Division, April 12, and of the Executive Board of the Council, April 15, at which favorable actions were taken; also a letter from Chairman George E. Hale was read and the following letter dated April 21 from Vice-Chairman Gano Dunn, of the Council:

Paragraph No. 3 of your letter of April 16* seems now to be all right; that is, if people do not make the mistake of regarding the five members drawn from the Engineering Foundation as directly, as distinguished from indirectly, representing the Engineering Foundation.

While these members are drawn from the Engineering Foundation and represent it *ex officio*, as it were, they are not selected by the Engineering Foundation, but by the Founder Societies.

I do not think this will cause any further misunderstanding, but if it should, we can speak of the members of the Engineering Division of the Research Council as consisting, among others, of three representatives from each of the Founder Societies, of whom one from each Society shall be drawn from the membership of the Engineering Foundation Board.

The report of the Special Committee on Relations with National Research Council, as recommended by the Executive Committee, was

* This letter transmitted the "proposals" quoted above.

adopted by the Foundation Board. To carry out certain provisions of the report, the Foundation engaged two offices on the sixteenth floor of Engineering Societies Building. The Division of Engineering moved into its New York office, from Washington, in June, 1919.

To a letter from Chairman Goss, of the Foundation, May 6, 1919, inquiring whether the Division was prepared to make any recommendation to the Foundation, covering specific researches, Acting Chairman Clevenger replied May 14, suggesting support of a research in the fatigue phenomena of metals.

Under date of July 29, 1919, the Division recommended that the Foundation undertake preliminary research in a number of subjects and underwrite the expense to an amount not exceeding $1500. The subjects named were: New Hardness Testing Machine, Elimination of Sonims from Steel, Uses of Cadmium, Uses of Alloy Steels, Pyrometers, Improvement of Metals at Blue Heat, Uses of Tellurium and Selenium, Neumann Bands in Iron and Steel, Heat Treatment of Carbon Steel, Pulverizing, Electrical Insulation, and Substitute Deoxidizers. August 20, the Executive Committee of the Foundation took action to support these preliminary investigations. When this preliminary research shall have been sufficiently advanced, a report will be made by the Division of Engineering to the Foundation with further recommendations as to specific researches which may be undertaken.

Research in Fatigue Phenomena of Metals

At its meeting of May 16, the Foundation Board declared its willingness to appropriate for this important research a sum not to exceed $15,000 per year for two years, contingent upon the submission by the Division of Engineering of an acceptable detailed plan for the conduct of the research. Such a plan has been submitted and approved. The work is to be done in the laboratories of the Engineering Experiment Station of the University of Illinois under the direction of Prof. H. F. Moore, in accordance with an agreement to which the University, the Engineering Foundation and the National Research Council are parties. This agreement provides that the Engineering Division's Committee on the Fatigue Phenomena of Metals shall constitute an Advisory Committee on the tests and the publication of results. The Experiment Station shall have the right to publish the results in full as a bulletin of the station, but in addition

shall prepare a brief, comprehensive statement suitable for publication in the journals of the Engineering Societies.

Industrial Research

In May, 1916, the Foundation and the National Research Council appointed a joint special committee to formulate a scheme for developing engineering and industrial research. This joint committee recommended an Industrial Research Section with two committees: (1) an advisory committee, (2) an active committee. In the reorganization of National Research Council after the Armistice, a Division of Industrial Relations was substituted for the active committee on industrial research, and the advisory committee now exercises the advisory function for the National Research Council as a whole. Of the Division of Industrial Relations, the Secretary of Engineering Foundation is a member. To him was assigned in May, 1918, the collecting of information about existing industrial research laboratories in the United States. After correspondence and inquiry extending through fifteen months, names of approximately two hundred and fifty laboratories connected with the industries, which give whole or part time to industrial research and development, as distinguished from routine investigations and tests, have been collected. Some information has been assembled and classified concerning each of these laboratories. This body of information, which it is believed will be of much use, is being prepared for publication under the joint auspices of the Engineering Foundation and the Division of Industrial Relations of National Research Council.

OTHER INVESTIGATIONS

From approximately fifty suggestions made to date, the Engineering Foundation Board has selected for investigation: (1) wear of gears, (2) spray camouflage for ships, (3) directive control of wireless communication, (4) weirs for measurement of water, (5) establishment of a testing station for large water wheels and other large hydraulic equipment, (6) mental hygiene of industry. Investigations numbers 1, 3, 4, and 6 are in progress; the other two have been completed.

In February, 1916, for an experimental study of the wear of gears an appropriation of one thousand dollars was made to Professors Guido H. Marx and William F. Durand, of Leland Stanford Junior University. A special machine has been designed and built

for the purpose of this investigation and some tests made. Progress was interrupted by the war. Service to the Government during the war obliged Professor Durand to give up his share in the work. He was succeeded by Professor Lawrence E. Cutter.

To aid in solving the problem of protecting ships from attack by submarines, Engineering Foundation, in November, 1917, joined with the New York Committee on Submarine Defense, Professor George B. Pegram, of Columbia University, Chairman, in making experiments on concealment by means of spray from special nozzles disposed at suitable points on the ship. Professor M. I. Pupin, Dr. Charles Warren Hunt and Mr. Edward Dean Adams were appointed a committee to coöperate with Professor Pegram in the supervision of the experiments. Under the immediate direction of Howard P. Quick, Mechanical Engineer, a barge lent by the United States Navy was equipped, and a number of tests made in New York harbor, which led to the conclusion that the method was not practical. An appropriation of two thousand dollars was made by the Foundation, but all expenses were otherwise met.

In order to investigate certain elements of methods proposed for the secret directive control of wireless communication, the sum of five hundred dollars was put at the disposal of Professor Pupin in March, 1918. A number of experiments have been made, but conclusions have not been reached.

Many experiments have been made upon weirs as means for measuring flowing water and other liquids. Several elements of the problem remain unsolved, and others have not been satisfactorily solved. In December, 1918, an appropriation not to exceed twenty-five hundred dollars was made for an investigation to be carried on under the direction of Clemens Herschel, Hydraulic Engineer, in collaboration with the Hydraulic Laboratory of the Massachusetts Institute of Technology.

In December, 1918, Julius Alsberg, Consulting Hydraulic Engineer, suggested the establishment of a testing station for large water wheels and other large hydraulic equipment. Silas H. Woodard, H. Hobart Porter and Calvert Townley were appointed a committee to inquire into this subject. This committee reported in May, 1919, that such a testing station was not practical, that it is not advisable to establish a testing flume for small models because existing flumes meet all requirements, but that testing of water wheels now in place would be useful and practicable.

In February, 1919, the Foundation authorized Dr. E. E. Southard, Director, Massachusetts State Psychiatric Institute, to make a preliminary investigation as to the part played by mental abnormalities in industry. Upon the presentation of a report in May, showing satisfactory preliminary results, for which an expenditure of three hundred dollars had been made, twenty-five hundred dollars were appropriated for a research in mental hygiene of industry to be made under Dr. Southard's direction during the twelvemonth beginning June 1, 1919. Dr. W. F. M. Goss, J. Parke Channing, E. W. Rice, Jr., and Thomas T. Read were appointed an advisory committee. The objects of this research are to develop or discover methods for adapting psychopathic individuals to usefulness in industry and to prevent them from becoming sources of disturbance, in so far as these ends may prove attainable.

The Foundation Board realized, however, that the research in mental hygiene of industry dealt with only one of many elements of the industrial personnel problem. Therefore, in June, 1919, the Board addressed to the National Research Council a letter proposing a coördinated, broad research in problems of industrial personnel. In response, the Council appointed a committee consisting of representatives of its divisions of Anthropology and Psychology, Educational Relations, Engineering, Industrial Relations and Medicine, and the Chairman of the National Research Council, to consider means of furthering the study of the problems of industrial employment.

The problem of engineering organization, because of its exceptional importance, commended itself to the Engineering Foundation Board as one well worthy of its attention. From time to time groups of engineers have associated themselves in the formation of societies, some local, some national, having purposes which are variously stated, and designated to serve groups variously defined. The value of all such organizations would be enhanced if localized activities could be coördinated; if the national undertakings could be effectively interwoven with the local; and if the purpose and functioning of all could be made to harmonize with the profound changes in the social and industrial relationships resulting from the more recent application of the fundamental sciences.

The problem of outlining a proceeding which may serve to bring about improvement is, broadly stated, not one of an individual society nor of any single locality, but one which, on the contrary, in its

extent, is all-embracing in its classification, and as a consequence one which can best be developed through the aid of a neutral agency.

In September, 1918, the Foundation offered to the four Founder Societies to undertake an investigation of this problem along the broadest lines, calling to its aid highly qualified experts, and availing itself of the help of agencies willing to coöperate. The Board in proposing this research had no desire nor purpose to intrude upon the domain of individual organizations, nor to control the action of any individual organization, nor to ask the acceptance of its conclusions; but its purpose was to develop a possible procedure, or a series of procedures, of such evident merit that they would appeal to those who were likely to be most interested. For reasons which seemed to be good and sufficient, this investigation was not undertaken.

NATIONAL RESEARCH COUNCIL

AN ORGANIZATION AFFILIATED WITH THE ENGINEERING FOUNDATION

An Outline of Its Organization and Functions

NATIONAL Research Council is an organization of American scientists, engineers and educators, established in April, 1916, under the Congressional charter of the National Academy of Sciences, given in 1863. It comprises representatives of national scientific and technical societies, chiefs of technical bureaus of the Army and the Navy, heads of governmental bureaus engaged in scientific research, representatives of other research organizations, and other persons whose aid may advance the objects of the Council.

The principal duties of the Council are defined in the following abridged statements from the Executive Order issued by the President of the United States, May 11, 1918:

To stimulate research in the mathematical, physical and biological sciences and in the application of these sciences to engineering, agriculture, medicine and other useful arts;

To survey the larger possibilities of science, to formulate comprehensive projects of research, and to develop means for dealing with these projects;

To promote coöperation in research in order to secure concentration of effort, minimize duplication, and stimulate progress;

To gather and collate scientific and technical information at home and abroad and to render such information available.

The membership of the National Research Council is chosen with the view of making the Council an effective federation of the principal research agencies in the United States concerned with the fields of science and technology. The Council is organized in thirteen divisions of two classes:

(A) Six divisions dealing with the more general relations and activities of the Council:

I. Government Division.
II. Division of Foreign Relations.

III. Division of States Relations.
IV. Division of Educational Relations.
V. Division of Industrial Relations.
VI. Research Information Service.

(B) Seven divisions of science and technology:

VII. Division of Physical Sciences.
VIII. Division of Engineering.
IX. Division of Chemistry and Chemical Technology.
X. Division of Geology and Geography.
XI. Division of Medical Sciences.
XII. Division of Biology and Agriculture.
XIII. Division of Anthropology and Psychology.

The Division of Engineering includes twenty-eight members, nominated as follows and elected by the National Academy of Sciences:

American Society of Civil Engineers	three
American Institute of Mining and Metallurgical Engineers	three
American Society of Mechanical Engineers	three
American Institute of Electrical Engineers	three
American Society for Testing Materials	one
Society of Automotive Engineers	one
Illuminating Engineering Society	one
Western Society of Engineers	one
Members at Large, nominated by the Division	twelve

At least five of the representatives are members of the Engineering Foundation, one of whom is the Chairman of that body.

National Research Council is supported by gifts and appropriations from private foundations, industries, individuals and the Government. Its main office is at 1201 Sixteenth Street, Washington, D. C., and it has a branch office in Engineering Societies Building, 29 West Thirty-ninth Street, New York.

George E. Hale, Director of the Mount Wilson Solar Observatory, was the first chairman of National Research Council. Upon Dr. Hale's resignation in May, 1919, he was succeeded by John C. Merriam, Professor of Paleontology, University of California. By election, James R. Angell, Dean of University Faculties, University of Chicago, became chairman July 1, 1919.

FORM OF BEQUEST FOR ENGINEERING FOUNDATION

I give to UNITED ENGINEERING SOCIETY, *a New York corporation, whose principal office is in the City of New York, the sum of ..... dollars ($.....), for the Engineering Foundation maintained by said society.*